# IMMUNOGENIC COMPOSITIONS AND USES THEREOF

## CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application is a division of U.S. patent application Ser. No. 16/392,137, filed Apr. 23, 2019, which is a continuation of U.S. patent application Ser. No. 15/907,259, filed Feb. 27, 2018, now U.S. Pat. No. 10,279,029, which is a division of U.S. patent application Ser. No. 15/081,601, filed Mar. 25, 2016, now U.S. Pat. No. 9,974,850, which claims the benefit of U.S. Provisional Patent Application No. 62/137,922, filed Mar. 25, 2015, the entirety of each of which is incorporated herein by reference. This application is also related to U.S. patent application Ser. No. 13/750,774, filed Jan. 25, 2013, the entirety of which is incorporated herein by reference.

## STATEMENT OF GOVERNMENT INTEREST

**[0002]** This invention was made with government support under Grant no. U01 AI078045 awarded by National Institutes of Health, NIAID. The government has certain rights in the invention.

## INCORPORATION OF SEQUENCE LISTING

**[0003]** The sequence listing that is contained in the file named "UTSBP1053USD2_ST25.txt", which is 2 KB (as measured in Microsoft Windows(I) and was created on Jul. 26, 2020, is filed herewith by electronic submission and is incorporated by reference herein.

## BACKGROUND

**[0004]** Vaccination has increased the average human lifespan worldwide more than 10 years during the 20th century. Breakthroughs in immunology, molecular biology and biochemistry in the last 25 years produced more than half of the vaccines used during the last 100 years. Despite this, little progress has been made in delivery since most are injectable and require strict maintenance of cold chain conditions.

**[0005]** Injectable vaccines have various drawbacks. Injections are the most common reason for iatrogenic pain in childhood and deter many from immunization. Injectable vaccines pose a significant risk to the safety of medical staff, patients and community. And most vaccines are unstable at ambient temperatures and require refrigeration.

## SUMMARY

**[0006]** In a first embodiment, there is provided an immunogenic composition comprising a recombinant virus vector (e.g., a recombinant virus vector comprising an expression cassette encoding a heterologous antigen), said recombinant virus vector formulated in a pharmaceutically acceptable carrier comprising: (i) PMAL-C16 or (ii) from about 0.1% to 10% of a zwitterionic surfactant. In some aspects, the pharmaceutically acceptable carrier comprises PMAL-C16, such as about 0.1 to 50 mg/ml, 1 to 40 mg/ml, 1 to 30 mg/ml, 1 to 20 mg/ml, or 5 to 15 mg/ml (e.g., about 10 mg/ml) of PMAL-C16. In further aspects, the pharmaceutically acceptable carrier comprises about 0.1% to 10%, 0.5% to 10%, 0.5% to 5%, 1% to 10%, or 1% to 5% of PMAL-C16. In further aspects, the carrier comprises from about 0.1% to 10%, 0.5% to 10%, 0.5% to 5%, 1% to 10%, or 1% to 5% of a zwitterionic surfactant. In particular aspects, the zwitterionic surfactant has a lipid group having a carbon chain of 13-30 carbon atoms. In further aspects, the carrier also comprises a pH buffering agent (e.g., phosphate buffered saline). In certain aspects, the carrier has a pH of between 5.0 and 8.0, between 5.5 and 8.0, between 6.0 and 8.0, between 6.0 and 7.5 or between 6.1 and 7.4. In still a further aspect, the pharmaceutically acceptable carrier comprises a liquid and comprises between about $1\times10^5$ and $1\times10^3$, $1\times10^6$ and $1\times10^3$, $1\times10^7$ and $1\times10^3$, $1\times10^7$ and $1\times10^2$, $1\times10^8$ and $1\times10^2$, $1\times10^9$ and $1\times10^2$, or $1\times10^{10}$ and $1\times10^{13}$ infectious virus particles (e.g., of adenovirus) per ml. In yet further aspects, a composition of the embodiments is defined as able to retain at least about 10%, 50%, 70%, 80%, 90% or 95% (e.g., 80-95%) of the starting concentration of infectious virus after storage at room temperature for 2 months, 4 months, 6 months or 8 months.

**[0007]** In a further embodiment there is provided an immunogenic composition comprising a recombinant virus vector (e.g., a recombinant virus vector comprising an expression cassette encoding a heterologous antigen), said recombinant virus vector formulated in a substantially solid carrier comprising: (i) PMAL-C16 or (ii) from about 0.1% to 10% of a zwitterionic surfactant. In some aspects, the substantially solid carrier comprises less than about 10%, 5%, 4%, 3%, 2%, 1%, 0.5% or 0.1% water. In certain aspects, the substantially solid carrier comprises PMAL-C16, such as about 0.1 to 50 mg/ml, 1 to 40 mg/ml, 1 to 30 mg/ml, 1 to 20 mg/ml, or 5 to 15 mg/ml (e.g., about 10 mg/ml) of PMAL-C16. In further aspects, the substantially solid carrier comprises about 0.1% to 10%, 0.5% to 10%, 0.5% to 5%, 1% to 10%, or 1% to 5% of PMAL-C16. In further aspects, the substantially solid carrier comprises from about 0.1% to 10%, 0.5% to 10%, 0.5% to 5%, 1% to 10%, or 1% to 5% of a zwitterionic surfactant. In particular aspects, the zwitterionic surfactant has a lipid group having a carbon chain of 13-30 carbon atoms. In further aspects, the carrier also comprises a pH buffering agent (e.g., phosphate buffered saline). In certain aspects, the carrier has a pH of between 5.0 and 8.0, between 5.5 and 8.0, between 6.0 and 8.0, between 6.0 and 7.5 or between 6.1 and 7.4. In still a further aspect, the substantially solid carrier comprises a thin film and comprises a between about $1\times10^5$ and $1\times10^3$, $1\times10^6$ and $1\times10^3$, $1\times10^7$ and $1\times10^3$, $1\times10^7$ and $1\times10^{12}$, $1\times10^8$ and $1\times10^{12}$, $1\times10^9$ and $1\times10^{12}$, or $1\times10^{10}$ and $1\times10^{13}$ infectious virus particles (e.g., of adenovirus) per $cm^3$. In yet further aspects, a composition of the embodiments is defined as able to retain at least about 10%, 50%, 70%, 80%, 90% or 95% (e.g., 80-95%) of the starting concentration of infectious virus after storage at room temperature for 6 months, 12 months, 24 months or 36 months.

**[0008]** In still aspects, a composition of the embodiments further comprises a stabilizing agent, such as a sugar, a polymer, amino acids, such as glycine and lysine, or a lyoprotectant. In further aspects, the stabilizing agent comprises a carbohydrate stabilizing agent. For example, the stabilizing agent can comprise dextrose, mannose, galactose, fructose, lactose, sucrose, maltose, sorbitol, mannitol, pluronic F68, melezitose or mixture thereof.

**[0009]** In some aspects, the recombinant virus vector is a non-enveloped virus, such as a non-enveloped DNA virus. In further aspects, the recombinant virus vector is an adenovirus vector, such as a vector comprising a E1/E3 deletion.